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Health impacts of small-scale gold mining in Kenyasi, Ghana

Seth Appiah-Opoku*, William McWhorter and Joe Weber

Department of Geography, College of Arts and Sciences, University of Alabama, 230 Farrah Hall, Tuscaloosa, AL 35487, United States.

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Small-Scale Gold Mining (SSGM) is a way of life for many individuals living in mineral-rich but poverty-stricken areas of Africa. The sector provides many households with much needed income for their livelihood sustenance. Although the literature on SSGM have brought some consensus on environmental issues surrounding the sector, limited attention has been directed at health and safety issues associated with the small-scale gold mining processes. This paper contributes to fulfilling this gap. Based on a case study, the paper discusses the health and safety issues associated with each stage of the small-scale gold mining process. Mixed methods approach was used to gather relevant data and information through field observations, focus group discussions with miners, interviews with key informants, and content analysis of secondary data. The miners seem unaware of safe operating procedures and the health implications of the mining processes. Although formal regulations exist, there is lack of official oversight and monitoring of SSGM activities. Policy implications from the study are discussed. They include educating small-scale gold miners to raise health and safety awareness, and decentralizing permitting, monitoring and oversight responsibilities to local governments and institutions.

Key words: Galamsey, artisanal, small-scale mining, health and safety issues.

INTRODUCTION

Small-Scale Gold Mining (SSGM) is a major contributor to employment and poverty reduction in mineral-rich developing countries (Hentschel et al., 2003). Roughly 40.5 million people were directly engaged in SSGM in 2017 worldwide, up from 6 million in 1993. In contrast, only 7 million people worked in large-scale commercial or industrial mining by 2014 (IGF 2017). Today, an estimated 150 million people depend on SSGM across 80 countries in the global south (IGF 2017). More than a decade ago, Hayes and Wagner (2008) estimated that 9 million people were directly engaged in SSGM in Africa with another 54 million depending on the sector for livelihood. Thus, the sector provides financial security to families in some of the most poverty-stricken but mineral-rich regions.

SSGM is often regarded as a "get-rich-quick" activity pursued in communities lacking alternative employment avenues and reduces the tide of rural-urban migration in most African countries (IGF, 2017). Some writers use artisanal and small-scale mining interchangeably (Mwaipopo et al., 2004; Fisher et al., 2009). The former refers to the most rudimentary mining operations that use such simple tools as pickaxes, hammer and chisels whilst the latter refers to the more formalized small-scale mining

*Corresponding author. E-mail: sappiah@ua.edu .

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Table 1. Legislation governing mining in Ghana.

Legislation	Focus
Minerals Commission Law of 1986 (PNDC Law 154)	Created Minerals Commission and governs all things mining including ownership, land acquisition and permitting, regulation, etc
Small-Scale Mining Laws of 1989 (PNDC Laws 217, 218, 219)	Legalized SSGM, created a permit system, and provided avenues for SSGM to sale gold.
The Environmental Protections Agency Act 1994 (Act 490)	Created the EPA and governs all industry regulations and minimum discharges.
The Minerals and Mining Act of 2006 (Act 703)	Redefined Law of 1986. Updates all aspects of mining legislation.

(Source: Government of Ghana 1989).

activities that use some modern machinery and technology (Mwaipopo et al., 2004).

A generally lack of monetary resources and limited regulations have resulted in many financial shortcuts and hazardous working conditions that present health and safety concerns for both artisanal and small-scale gold miners.

Artisanal small-scale gold mining has been practiced for centuries in Ghana though it was not officially legal until the 1989 Small-Scale Mining Laws were enacted to formalize the sector and provide avenues for miners to sell their products (Hilson and Potter, 2003). Despite being legal in the country, bureaucratic hurdles have resulted in many operations in this sector choosing to forgo licensing and working informally as *galamsey* (a local parlance for 'gather-them-and-sell'). These operations extract gold from deposits that are uneconomical on a large-scale nor require capital-intensive methods for extraction. Lack of government capacity to efficiently regulate *galamsey* operations has exposed miners to unsafe and unhealthy working conditions. Although the literature on SSGM have brought some consensus on environmental issues surrounding the sector, limited attention has been directed at health and safety issues associated with the small-scale gold mining processes (IGF, 2017). This paper contributes to fulfilling this gap.

Earliest records on mining suggest the indigenous people of Ghana mined gold for several centuries before Europeans arrived on the coast of the country in the 14th century and named it Gold Coast (Ofosu-Mensah 2011).

Small-scale gold mining (SSGM) activities were restricted after the colonial government enacted the Concessions Ordinance of 1900 that prohibited any person or groups from searching for minerals without a prospecting license (Ofosu-Mensah, 2011). Under this law, international commercial mining companies were given large tracts of gold-rich land (Aryee et al., 2003). In addition, the colonial government passed a Mercury Ordinance of 1932 which made it illegal to use mercury for small-scale gold extraction (Hilson, 2002).

The colonial mining policy was amplified in the 1980s with the implementation of Ghana's Structural Adjustment Program (SAP). The SAP heavily favored commercial mining operations and hence SSGM activities were pushed aside or technically remained illegal until the Provisional National Defense Council (PNDC) Laws 217, 218, and 219 were decreed in 1989 by the then military government (Hilson and Potter, 2005). Under Ghana's Fourth Republic, subsequent laws to regulate and streamline the SSGM sector included the Environmental Protection Act of 1994 (Act 490) and the Minerals and Mining Act of 2006 (Table 1).

These laws were intended to create a permit system, ensure appropriate supervision, and reduce the inherent adverse health and environmental impacts associated with the SSGM sector. Today, the sector accounts for almost two-thirds of the entire mining labor force in the country including thousands of workers enduring unhealthy and hazardous workplace environments (Amponsah-Tawiah, 2011). Yet, the sector has become a source of survival for many families residing in mineral rich areas of Ghana (Hilson and Pardie, 2006).

Small-scale gold mining methods vary depending on the scale of the operation, types of deposit, and the amount of available financial resources. The generic approach begins when gold bearing deposits are suspected a permit may be required from the relevant body or institution, vegetation is cleared, and soil is excavated until a gold-rich layer is discovered. Upon reaching this layer, the sediment is removed and transported to a nearby stream where it is sluiced to separate gold-bearing minerals and then combined with mercury and burned to create gold nuggets.

This is the most common method used by SSGM operations due to its cost-effectiveness and ease of access (Aryee et al., 2003). Recently, more advanced SSGM operations have employed deep hard rock mining techniques to intercept gold bearing reefs at depths of more than 50 feet. These techniques are the most complicated and are usually only carried out by operations that have financial resources available to acquire machinery and possibly skilled workers.

Miners construct shafts and tunnels to intercept gold-bearing rock and then follow the reefs. Heavy machinery

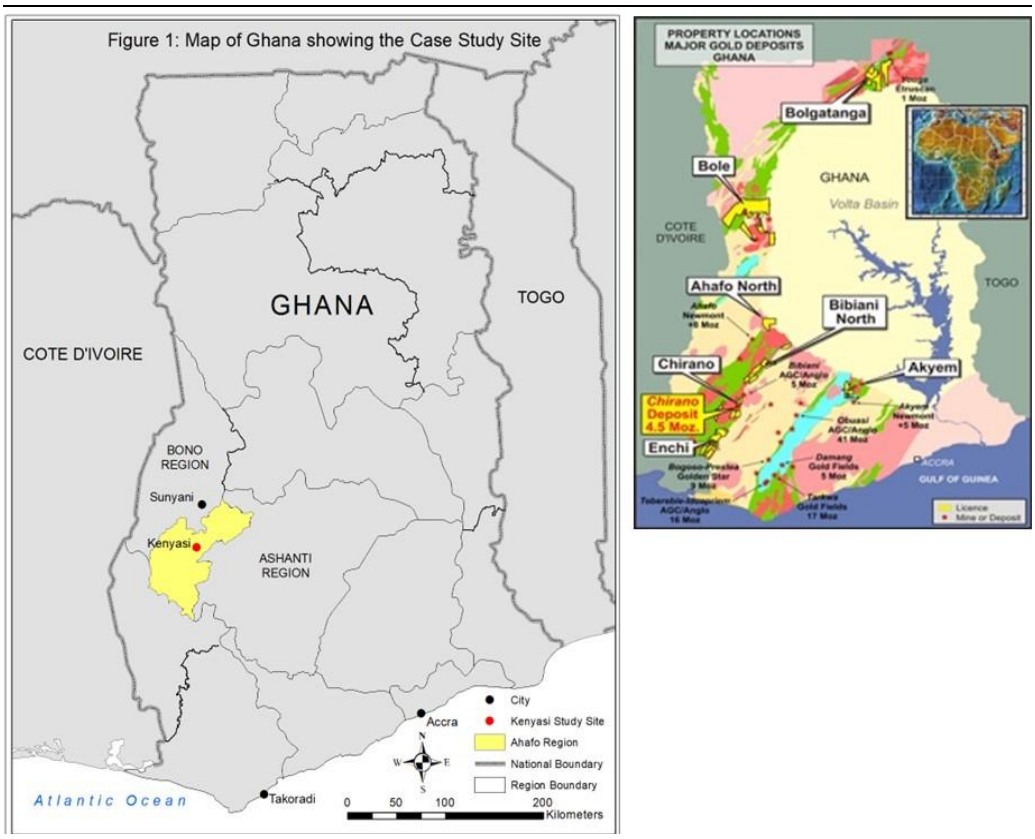

Figure 1. Study area.
Map Source: Authors, Minerals Map Source: Ghana Minerals Commission (2018).

or explosives are commonly used to break apart hard rock despite being officially illegal for SSGM operations. After the gold-bearing rock is excavated, it is crushed and milled before sluicing to isolate gold through mercury amalgamation (Aryee et al., 2003).

Bansah et al. (2016) have identified at least eight specific methods used to extract gold in the Ghanaian SSGM sector. They include the (a) *Anomabo* method which is used to scoop gold bearing gravels from river beds; (b) Chisel and hammer method which is used for mining hard rock formations occurring as outcrops; (c) Underground "ghetto" method for mining hard rock formations from old and abandoned underground mines; (d) Dig and wash method is used to mine alluvial gold deposits occurring on river banks, valleys, or terraces; (e) *Changfa* method which involves the use of a made-in-China diesel powered rock crusher; (f) the "More blade" method which involves the use of excavators for digging mine pits; (g) Dredge method involves direct suction of gold bearing sediments from a stream or riverbeds; and (h) Alluvial washing plant method which is a relatively more mechanized and less labor-intensive. With each of these techniques, SSGM workers are exposed to health and safety issues they are not equipped to handle. Based on a case study in Kenyasi, in the Ahafo region of Ghana, this paper discusses health and safety issues associated with SSGM in an attempt to promote more efficient policies and practices that could create a safer and healthier workplace for miners.

MATERIALS AND METHODS

Although gold deposits occur in several regions of Ghana, the majority of the Small-Scale Gold Mining (SSGM) operations are concentrated on areas around Bolgatanga, Bole, Ahafo North, Chirano, Enchi and Akyem (Figure 1).

Given the limitations of time and resources, this study focused only on one of these areas. The operations studied are located just outside Kenyasi in the Ahafo North and have been in existence since 2009 (Figure 1). The site was chosen due to its relative closeness to the researchers' summer field studies program camp in Sunyani. With institutional and official permission from the Ahafo District Assembly in Kenyasi, researchers were granted access to the SSGM sites where the extraction of gold in relatively small quantities occurs.

Mixed methods including participatory action research framework were applied. Relevant data and information were gathered through field observations, focus group discussions with miners, interviews with key informants, and content analysis of secondary data. Key informant interviews were conducted with key officials from the relevant government institutions. Data and information sought pertained to the steps in the gold mining process and the

Table 2. Health and Safety Issues.

Mining process	Activities	Safety issues	Health issues
Excavation	Suspected gold-bearing rocks are excavated using heavy machinery and explosives	Workers inhale silica dust and other particulate matter. High risk injury Noise pollution	Silica dust cause silicosis which has no known cure. Breathing problems Hearing impairment
Grinding	Hard rocks are passed through hammer mills to produce small grain ore	Workers inhale silica dust and other particulate matter, Noise pollution	Respiratory and cardiovascular problems, hearing impairment
Sifting	Small grain ores are passed through smoothing mills to produce fine grain ore	Workers inhale silica dust and other particulate matter	Respiratory and cardiovascular problems
Sluicing	Fine grain ores are sluiced to isolate ore containing gold	Workers are exposed to mercury ingestion	Kidney problems, Respiratory, central nervous and cardiovascular systems disorders
Amalgamation	Mercury is used to isolate gold from fine grain ore	Workers are exposed to mercury ingestion	Kidney problems, Respiratory, central nervous and cardiovascular systems disorders, reproductive problems, psychosis

Source: Author

health and safety issues at each stage of the process. Attention was focused on three aspects of the mining operations - (a) Mining/Excavation. (b) Extraction of gold, and (c) Communal structure of the operations and how they interact with each other to create gold nuggets.

RESULTS AND DISCUSSION

The mining operations in the study area cover several mini sites within the same vicinity, each with its own workers and management. The underground “ghetto” method is the most common technique used at the study site for mining hard rock formations from new or old and abandoned underground mines. Each site operates its own underground mining shaft. The shafts range in depth up to 100 feet and are dug until gold-bearing deposits are suspected. Miners dig tunnels and follow a gold-bearing reef (Figure 2). The tunnels are reinforced with wooden beams, and ventilation tubes are used to mitigate low oxygen levels, high temperatures, and dust. Although the use of explosives is illegal according to the 1989 Small-Scale Mining Laws in Ghana, the operations continue to use them to break apart hard rock within the tunnels (Government of Ghana, 1989). The handling and storage of explosives raise safety concerns. For instance, jackhammers are used to break apart hard gold-bearing rocks.

After a suspected gold-bearing rock is mined, it is uploaded to the surface and organized into sacks weighing roughly 50 pounds each (Figure 3). Each sack of suspected gold-bearing rock is sold for at least 480 Ghana Cedis ($55) to intermediary operators who extract the gold from the hard rock. The miners’ wages come from commissions on the sale of sack loads alone.

Therefore, the miners are incentivized to produce the most amounts of sack loads as possible to ensure they have enough money to provide for their families.

The sack loads of potential gold-bearing rocks are then transported to nearby improvised facilities and processed to isolate the gold. Here, hard rocks are spread over mats in the sun to ensure they are dry and small enough for machine processing. An individual is in charge of overseeing this step while manually seeking out larger stones to crush with a mallet. If stones are too large or not entirely dry, they can cause obstructions in the machinery. Once the size of stones or ore is deemed suitable, it passes through a series of mills to create a fine grain. The first mill is a hammer mill, commonly called a “crusher” by the local workers. It takes the larger stones and breaks them into small grain ore, typically about 2 cm in diameter (Figure 4a). This process is loud, and an abundant amount of silica dust is produced which is unhealthy for workers to breath into their lungs (Table 2). After this step, the small grain ore passes through another mill, called a “smoother,” which further refines the ore creating very fine grains (Figure 4b). This fine grain ore is then combined with water and sluiced to isolate ore containing gold (Figure 5a). Thereafter, it is combined with mercury to form an amalgam and eventually burned away leaving gold nuggets (Figure 5b). This gold is then sold through informal channels. Each of the operations at the site is able to secure at least between 10 and 15 pounds of gold per week. Figure 6 depicts the observed gold mining process at the study site.

Although the mining operations belong to different owners, they seemed linked and rely on the others for

Figure 2. Mining shaft.
Source: Author

Figure 3. Potential gold bearing rock.
Source:Author

Figure 4a. Hammer mill.
Source:Author

Figure 4b. Smoother mill.
Source:Author

Figure 5a. Washing.
Source:Author

Figure 5b. Sluicing.
Source:Author

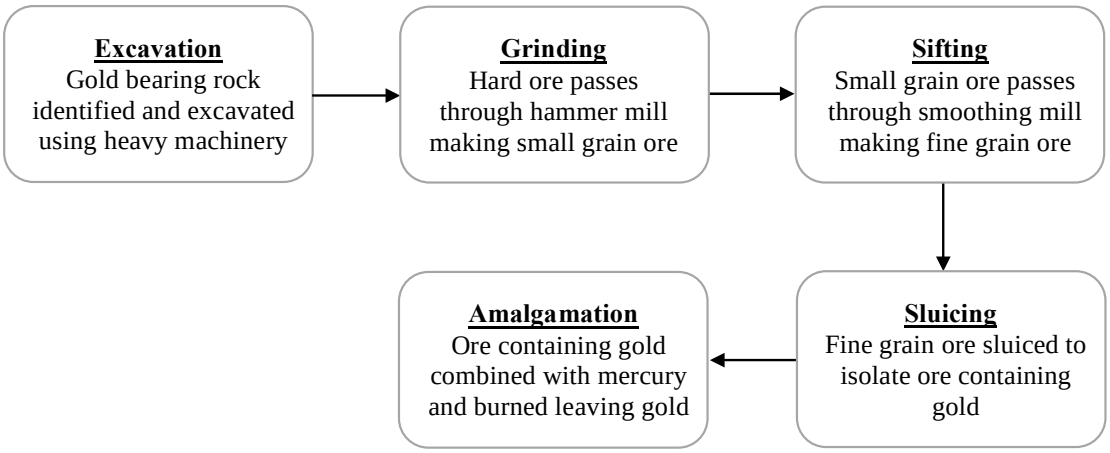

Figure 6. Overview of observed SSGM process.
Source: Field data

success. There are secondary economic benefits seen within and around the mining sites on the outskirts of Kenyasi. Several vendors and restaurants exist at the site, and the roadside was filled with petty traders and taxis taking people to and from the site. In this sense, the occupational health and safety hazards may not only affect the miners but also their families and immediate community either directly or indirectly. Due to the expansive and complex nature of the current operations at the sites, the miners have created a local mining council to manage their affairs. The council is an informal body that consists of a Chairman, Vice-Chairman, General Secretary, Treasurer, and an unarmed policing task force. So far, the council has not implemented any measures to address health and safety issues at the sites. The mining operations here are informal and several of the mine workers do not seem to understand the consequences of the exposures to silica dust, mercury, and other elements.

Health and safety issues

Health and safety issues identified stem from a lack of Personal Protective Equipment (PPE) such as breathing masks, ear plugs, hard hats, gloves, safety boots and protective eyewear. Unbelievably, none of the workers was observed using a breathing mask and miners were descending into the shafts with no hard hats nor protective eyewear. They simply had a flashlight taped to a side of the head (Figure 2), while heavy machinery operators were without safety boots throughout the excavation process. It was observed at the grinding and sifting stage that some workers had no breathing masks. At the sluicing stage, workers handled mercury with their bare hands (Figures 5a and 5b).

Moreover, the waste products are dumped in a nearby stream and can therefore enter the food chain. In this sense, mine workers and the surrounding communities are being exposed to high levels of mercury pollution. Those interviewed do not seem to understand the long-term consequences of mercury in their bodies and the ecosystem.

Exposure to mercury is a cause for serious health concerns including kidney, respiratory, cardiovascular and central nervous disorders. Others include memory loss, psychosis and reproductive problems (Donkor et al., 2006; Oduro et al., 2012). The focus group discussions also revealed that none of the underground mine workers use ear plugs or hearing protectors to minimize the impact of noise pollution from blasting. Tunnel collapse is a cause for concern due to lack of inspections and reinforcement of tunnel walls. This elevates the likelihood of accidents occurring coupled with a lack of PPE and the general lack of health and safety awareness among the mine workers.

Regulatory institutions

Small-scale gold mining operations are required to abide by all applicable laws in the country including seeking permits from the relevant institutions. Yet, none of the operations at the site had secured a permit from any of the relevant institutions. The institutions include the Minerals Commission, Environmental Protection Agency (EPA), Forestry Commission, Lands Commission, and Water Resources Commission (Table 3). According to the miners, they operate informally because the process for obtaining SSGM permit is costly and lengthy. It can take upwards of 6-8 months for the registration process with the Ghana Minerals Commission alone. Similarly, no environmental permit was sought, as required by law, from the Environmental Protection Agency.

Table 3. Relevant government institutions.

Institution	Focus
Minerals commission	Responsible for regulating and managing all mineral resources in Ghana. Coordinates and implement policies relating to the mining sector. Assists the Minister responsible for mines with small-scale licensing procedures and monitoring of operations as well as establishing small-scale mining district centers.
Environmental protection agency	Carries out government policy, inspections, issues environmental permits, and regulations pertaining to the environment. Monitors activities of mineral rights holders to ensure compliance with terms and conditions. Has power to cancel, suspend or revoke mining permits.
The forestry commission	Regulates the use of forest and wildlife resources. Section 18 of Act 703 requires a mineral rights holder to obtain a permit from the Forestry Commission before mining activity is undertaken in the forest.
Lands commission	Manages public lands and registers title to land. Responsible for land valuation and compensation to individuals by mining companies.
Water resources commission	Responsible for the regulation and management of the utilization of water resources. Expected to monitor and sanction mining activities polluting water bodies.

(Source: compiled by authors).

Consequently, there is a lack of official oversight and monitoring of the mining operations at the site. Interviews with key officials in these institutions revealed the day-to-day challenges in the quest to address safety and health issues at the mining sites. There is a generally lack of personnel and logistics to monitor and enforce health and safety regulations as most of the SSGM activities are geographically scattered and not easily accessible by road. Since the SSGM operate informally, they are often at loggerheads with government officials attempting to monitor their operations and enforce the applicable laws. Also, there is insufficient coordination among the regulatory institutions to ensure compliance within the small-scale gold mining sector. The institutions are yet to have local presence in the Ahafo Region. The closest regional offices are located in Sunyani, the capital city of the Bono Region which is quite a distance from the study site.

Nicole et al. (2016) observed that safety and health issues surrounding small-scale gold mining often focus on the need for mercury-free mining technologies but the foregoing findings reveal other pressing issues. For instance, silica dust accumulates throughout the excavation, grinding, and sifting processes. According to the United States Department of Labor (2002) silica dust is harmful to breathe and has been classified as a human lung carcinogen. The silica dust can also cause silicosis which has no known cure. It causes scar tissue to build in the lungs and eventually reduces the victim's ability to take in oxygen or become more susceptible to lung infections such as tuberculosis. Due to the slow and chronic nature of impacts to health by silica dust, many workers do not realize the extent of the damage until it is too late (Nicole et al., 2016).

During the final stage of the gold extraction process, workers use mercury to isolate gold from fine grain ore. Due to a lack of PPE use, there are no barriers between mercury and the workers thus causing elevated risks for mercury-related health impacts. This is because mercury is a neurotoxin, and bio-accumulates, meaning that once absorbed by an organism it accumulates due to the long biological half-life and the rate at which it is lost by catabolism and excretion (Tschakert 2007). Prolonged exposure to mercury leads to mercury poisoning which can cause difficulty breathing, tremors, emotional changes, neuromuscular impacts, kidney damage, and respiratory failure depending on the levels of exposure (Veiga et al., 2006; United States Environmental Protection Agency, 2017). When used in the gold extraction process, it forms an amalgam and turns into methyl-mercury compound. When emptied into rivers and other water bodies it can easily enter the food chain (Oduro et al., 2012). A study by Ghana's Council for Scientific and Industrial Research (CSIR) revealed that many SSM communities in the Western Region of the country are at risk of serious health-related problems due largely to mercury in water bodies (Yeboah, 2013).

There seems to be appropriate regulations in place through the 1989 Small-Scale Mining Laws, but Ghana continues to struggle with illegal small-scale activities through unregistered operations and the use of banned extraction techniques (Hilson et al., 2007). In this case study, it is obvious current government institutions lack the capacity to effectively oversee and regulate SSGM in ways that ensure to healthy and safe mining activities. According to Teschner (2012), mining laws in Ghana are not effectively capturing small-scale goldmining activities. This is largely because of the top-down regulatory framework of the central government. A bottom-up approach through local government would be more efficient as it can create a mutually beneficial relationship. Decentralization of oversight responsibilities could be

the best antidote to the failed centralized bureaucratic system (Agomor et al., 2019). Unlike central government institutions, local governments are closer to SSGM sites and are therefore in a better position to help mitigate the health and safety vulnerabilities associated with small-scale goldmining activities. They are well-positioned to improve service delivery at the local levels. Many individuals in rural mining communities heavily rely on mining as a source of revenue that ensures the well-being of their households (Tuokuu et al., 2018). Local governments could implement educational programs or workshops to raise miners' knowledge and awareness of health and safety issues associated with the SSGM sector. They can be given the oversight responsibilities of mining operations including helping to formalize those operations. This would be mutually beneficial for both the local government and SSGM operations. Local governments would enjoy increased tax revenues from SSGM operations that could help provide essential infrastructure needs in rural communities such as maintaining roads, providing reliable electricity, and potable water. This relationship could spark a positive feedback loop and facilitate exponential growth and sustainability in rural mining communities.

Conclusion

The literature on SSGM has largely focused on the environmental impacts and the root causes of its prevalence. In a recent paper, Achina-Obeng and Aram (2022) reveal that the desire for economic survival remains a major priority of small-scale gold miners than the conservation of the environment. This is not strange because limited attention has been directed at uncovering the health and safety issues associated with the small-scale gold mining processes.

This paper highlights health and safety issues at each stage of the small-scale gold mining (SSGM) process. Despite being legal, bureaucratic hurdles have resulted in many SSGM operations choosing to operate as informal entities.

There is a lack of official oversight and monitoring of the SSGM operations due largely to the failure of centralized bureaucratic institutions as the latter faces several challenges. The challenges include: (a) lack of coordination and overlapping regulatory functions; (b) inadequate personnel and logistics to monitor and enforce health and safety violations; and (c) the need to raise the awareness of the mine workers regarding safety and health impacts of mining activities through occasional workshops. Generally, the miners seem unaware of safe operating procedures and the health implications of the mining processes. Education and decentralization of oversight responsibilities to local governments and institutions is the key to mitigating negative health impacts associated with SSGM operations in Ghana and similar African countries.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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